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AUTHOR Brooks, Larry W.; Dansereau, Donald F.
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ABSTRACT

Previous research conducted from a schema theory perspective has neglected those instances where the reader is confronted with unfamiliar text. This issue is addressed, and initial results on training students to acquire and use form schema in processing relatively unfamiliar descriptive prose are presented. Thirty-two college students were randomly assigned to two groups: the DICEOX group which received training on the use of knowledge schemata and the control group which did not receive training. A 2,500-word passage dealing with the theory of plate tectonics was used as the material to be learned. The Group Embedded Figures Test (GEFT) and the Delta Vocabulary Test were employed as measures of individual differences. Dependent measures consisted of an essay test, short answer test, multiple choice test, and cloze test. A 2 x 2 analysis of covariance was conducted for each of the four dependent measures. Results revealed that: (1) the DICEOX group performed significantly better than the control group on the essay exam measuring comprehension and recall of descriptive prose material, but did not perform better on the other three dependent measures; and (2) high scorers (field independent) on the GEFT significantly outperformed low scores on all the dependent measures. (Author/RL)

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Knowledge Schema Training and Descriptive Prose Processing

Larry W. Brooks

Donald F. Dansereau

Texas Christian University

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Abstract

Previous research conducted from a schema theory perspective has neglected those instances where the reader is confronted with unfamiliar text. The present study addresses this issue and presents initial results on training students to acquire and use form schema in processing relatively unfamiliar descriptive prose. In addition, the relationship between field dependence and schemata usage was assessed. In general, it was found that schema training did facilitate the comprehension and recall of relatively unfamiliar text, and that field dependence, while not interacting with the training procedure, did significantly relate to prose processing.

Knowledge Schema Training, Field Dependence and Descriptive Prose Processing

In recent years schema theory has been the focus of numerous research efforts in the prose processing literature (e.g., Anderson, 1977). The central proposition of schema theory as it applies to text processing is that the prior knowledge of the reader and the context of the situation (titles, headings, and other immediately preceding material) interact to influence the interpretation and subsequent recall of new information. From this conceptualization the prior knowledge of the reader is seen to be organized as a set of schemata (abstract place keepers), and the context of the situation is thought to activate or inhibit particular sets of schemata.

Prior studies demonstrating the impact of schemata on text processing have been limited to the activation of familiar schemata already existing within the learner's repertoire (e.g., "Washing Clothes," Bransford & Johnson, 1973). However, in dealing with relatively unfamiliar academic material one could not expect learners to have coherent schemata already available. In these instances processing effectiveness should be enhanced by providing the learner with a content-free schema that contains information about the categories of knowledge pertinent to specific topics (e.g., scientific theories, biological systems). The purpose of the present research was to develop and assess one type of content-free schemata. To provide background for this endeavor a brief discussion of the relevant aspects of prior writings on schema theory and research will be presented.

Two types of schemata have been identified by Rigney and Munro (1977)--content and form schemata. These two classes of schemata vary along a continuum of specificity and abstraction. At one end of this continuum are content schemata which can be thought of as being relatively specific and concrete. As an example, a content schema for a journal article would possibly include the topic of the article, and specific information on the statistical techniques employed. On the other hand, the more abstract form schemata would be likely to contain general information about the format of the article (e.g., the fact that most articles consist of the following sub-sections: introduction, method, results, and discussion).

Obviously, the distinction between content and form schemata is somewhat arbitrary, but it does serve to point out an important dimension along which schemata can vary. As stated earlier, prior research on prose processing from the schema perspective has typically employed the activation of relatively specific content schema that are derived from the individual's experiences in a particular domain (e.g., "Washing Clothes," Bransford & Johnson, 1973). This type of schema clearly plays an important role in understanding and recalling narrative prose, but does not seem to be directly generalizable to many types of academic materials where the individual does not have a stored set of directly relevant experiences (e.g., understanding the theory of "continental drift"). In these situations it would appear that more abstract form schemata would be of greater importance. In particular, the processing of academic material should be facilitated by form schemata which specify the set of categories of information a well-informed learner should know about a particular topic (these types of schemata will be labeled knowledge schemata). While this

aspect of schema theory has not been investigated it is an important one if schema theory is to have practical implications for academic learning. By focusing on the use of knowledge schemata as facilitators of descriptive prose learning the present experiment is an initial step in expanding schema theory to the field of applied educational psychology.

Knowledge schemata as defined here are analogous to Kintsch's (1977) schemata for stories. These story schemata contain the general frames or categories that are typically important in understanding narrative prose. The results of an experiment by Thorndyke (1977) support the importance of these types of narrative schemata. He found that subjects who initially received a narrative passage identical in structure but unrelated in content to a target passage recalled 22% more of the information in the target text than did subjects who initially received a narrative passage unrelated in both structure and content to the target passage.

Also related to the present use of knowledge schemata is Anderson, Spiro, and Anderson's (1977) example of a Nation schema. Although these authors did not research the effectiveness of this type of schemata, they have speculated that a mature reader, when encountering a passage concerning an unfamiliar nation, will have an already formed schema with categories for important characteristics (e.g., topography, economy, etc.) that are generally associated with a nation. The learner's task then is to fill in each of these categories with the appropriate information.

The knowledge schema to be employed in the present study specifies the categories of knowledge representing an individual's understanding of a scientific theory. This schema was created on

the basis of a survey given to thirty individuals at various levels of education (e.g., from freshman college students to upper level graduate students). The survey required each person to list what he or she considered to be the important categories of information relevant to understanding a scientific theory. Informal analysis revealed that these responses could be subsumed under six basic headings. Each of these six categories could be further divided into sets of subcategories. This information was then combined to form the following knowledge schema (given the acronym DICEOX to facilitate retention):

1. DESCRIPTION -- A short summary of the theory which should include:
   a. Phenomena
   b. Predictions
   c. Observations
   d. Definitions
2. INVENTOR/HISTORY -- A brief account of the theory's history which should include:
   a. Name(s)
   b. Date
   c. Historical background
3. CONSEQUENCES -- A concise summary of how the theory has influenced man. This should include:
   a. Applications
   b. Beliefs

4. EVIDENCE -- A short summary of facts which support or refute the theory. This should include:
   a. Experiments
   b. Observations
5. OTHER THEORIES -- A concise summary of theories dealing with the same phenomena. These are usually of two types:
   a. Competing theories
   b. Similar theories
6. X-TRA INFORMATION -- An open category which should include any important information not in one of the other five DICEOX categories.

In addition to examining the general impact of the DICEOX schema, the present study is designed to determine whether there are discernible differences among individuals which are related to schemata usage in processing text material. It is only recently that individual differences have become a subject of investigation within the context of schema theory. A study by Spiro and Tirre (1980) supports the hypothesis that individual differences in cognitive style are relevant to schema utilization in processing narrative prose. Specifically, this study demonstrated that high scorers on the Group Embedded Figures Test (GEFT) recalled more items from a passage (restaurant script) with a highly articulated schema than did low GEFT scorers. Further, it was found that when given a passage (supermarket script) with a less structured schema both GEFT subgroups recalled passage items equally well. These

findings suggest that individuals who are relatively more field dependent or "stimulus bound" as measured by the GEFT are also more likely to be "text-bound" in their discourse processing.

The current study attempts to extend these findings by assessing whether or not field independence as measured by the GEFT will differentially affect knowledge schema usage with descriptive prose material. Two possible outcomes seem probable under the current conditions. One is that those participants who are better at disembedding figures on the GEFT may also benefit more from training on the use of knowledge schema as processing aids than participants who score lower on the GEFT, and that there will be no difference in test performance between high and low scorers on the GEFT for the control group. This assumption is based on the reasoning that (1) locating and recognizing informational sub-sets within a prose passage (a required task in using the DICEOX schema) is analogous to finding a simple figure within a more complex figure, and (2) that most participants regardless of degree of field dependence will not have a pretraining knowledge schema to aid them in processing the text material. A second possible result would be that participants who score as field independent on the GEFT will outperform low scorers on the GEFT in both the training and control conditions. This pattern of results would be expected if it is assumed that field independent participants have an already established knowledge schema and use it as an aid in processing descriptive prose.

In summary, the present study addresses two experimental questions:

(1) Does training on the use of a knowledge schema facilitate the processing of scientific text?

(2) Is performance on the GEFT related to the effectiveness of training on the use of a knowledge schema as a learning aid?

Method

Participants

Thirty-two students enrolled in a Techniques of College Learning class participated as part of their course requirement. These students were randomly assigned to two groups: the DICEOX group (n=15), which received training on the use of knowledge schemata, and the control group (n=17), which received instruction and participated in group discussion on concentration management during studying and test-taking.

Materials

A 2,500-word passage dealing with the theory of plate tectonics was used as the material to be learned. This passage, which was extracted from an introductory college level geology textbook, has been used in previous studies on prose processing (e.g., Dansereau, Holley, Collins, Brooks, & Larson, 1980, Note 1). All passage headings were deleted because of their possible effect as schematic cues. It should be emphasized that the plate tectonics passage and the DICEOX schema were developed independently of each other. Further, an examination of the passage indicated that it was not organized

according to the DICEOX categories. Rather, the categories of information were interweaved throughout the passage.

The previously described knowledge schema referred to by the acronym DICEOX was used in training half of the participants.

The Delta Vocabulary Test (Deignan, 1973) and the Group Embedded Figures Test (Oltman, Raskin, & Witkin, 1971) were employed as measures of individual differences. The Delta Vocabulary Test has been used in prior experiments on prose processing (e.g., Dansereau, Collins, McDonald, Holley, Garland, Diekhoff, & Evans, 1979), and has been shown to have moderate correlations with other measures of verbal ability such as the Scholastic Aptitude Test.

Dependent measures consisted of the following:

(1) Essay Test -- Participants were asked to produce a well-organized summary of the stimulus passage.

(2) Short Answer Test -- Consisted of 13 items designed to tap participants' knowledge of selected important topics discussed in the passage.

(3) Multiple Choice Test -- Consisted of 36 four- and five-choice items.

(4) Cloze Test -- Consisted of 36 "fill-in-the-blank" items. Participants filled in key concepts deleted from selected segments of the studied passage.

All of the above measures have been used in prior studies (e.g., Dansereau et al., 1980, Note 1), and the short answer, multiple choice, and cloze exams have been modified on the basis of item analyses. Test items were not selected on the basis of their

relationship to the DICEOX categories.

Procedure

In the first session participants were asked to sign consent forms, and were given the individual difference measures. In a subsequent session all participants were randomly divided into two groups. The DICEOX group received six hours of instruction over a two-week period on the use of knowledge schemata as learning aids. This training occurred in two phases. In the first phase this group was introduced via workbooks to a number of knowledge schemata related to five basic informational areas typically encountered in college learning (theories, events, systems, techniques, and objects). In the second phase participants were trained on the use of a particular knowledge schema (DICEOX) relevant to learning scientific theories.

Aspects of this latter training included having the participants do the following:

(1) Memorize the DICEOX schema.

(2) Organize their text notes according to the DICEOX schema using prepared format sheets as a guide.

(3) Use the DICEOX schema as a retrieval and organizational aid while taking tests over text material.

During the course of this training the participants practiced these techniques on three passages of approximately 750 words in length. Participants were allowed to use either experimenter provided passages or to use passages relevant to their other courses. All of the practice material used during the training period was unrelated in content to the dependent measure passage (plate tectonics.)

The second group (control) received training on support strategies (Dansereau et al., 1979) during the same two-week period. This training introduced the participants to relaxation techniques, study time management systems, and affective control strategies as aids in learning. This information was communicated via written text material, short lectures, and small group discussion. Participants were instructed to use these techniques in their regular coursework.

After the two week training period both groups were given the passage on plate tectonics to read and study for 55 minutes. The training group also received organizing sheets with the major categories of the DICEOX schema printed on them, and were instructed to use these sheets to help them in taking notes on the text. The control group received blank notepaper.

The final session occurred five days later. During this time period all participants were given the four dependent measures described earlier. A total time of 55 minutes was allowed for completion of these tests.

Results and Discussion

All of the dependent measures were scored without knowledge of group affiliation, and according to predetermined keys. The essay exam was scored only for its informational content and not for its organizational structure. Also, in order to assess inter-rater reliability for scoring of the essay test, a random subset of these exams was scored by a colleague not otherwise associated with the experiment. A reliability coefficient of .93 was obtained, and considered an adequate degree of reliability between the two scorers.

A 2 x 2 analysis of covariance, with Delta Vocabulary scores as the covariate, was conducted for each of the four dependent measures (i.e., essay, short answer, multiple choice, and cloze). The DICEOX and control groups comprised the first factor. While the second factor consisted of high and low (median split) GEFT sub-groups. This approach to investigating individual differences using a dichotomized continuous variable has proven useful in previous research (Das & Kirby, 1978). While it is a potentially less powerful technique than correlational analysis, it becomes problematic generally only when results related to the dichotomized variable are nonsignificant.

Although the four dependent measures are not strictly independent, separate analyses of covariance were performed to explore the possibility that various levels of testing may be differentially sensitive to the treatment effect.

Also, in order to obtain equal cell frequencies for the factorial ANCOVAs, one participant was deleted from the DICEOX group (n=15), and three participants were dropped from the control group (n=17), giving a total of 14 participants for each group with 7 participants per cell. All participants were deleted randomly, and the same set of participants was used in all analyses.

Before computing the four analyses of covariance, the equality of within-groups regression slopes were tested for each ANCOVA. These analyses indicated that, in all cases, the assumption of homogeneity of within-group regression coefficients was not violated ($F_s \leq .067$, d.f. = 3,20, $p_s \geq .58$). Consequently, the analyses of covariance were conducted as planned.

Results related to the first experimental question revealed that the DICEOX group performed significantly better than the control group on the essay exam ($F = 6.59$, d.f. = 1/23, $p < .02$). However, this effect was not significant for the other three dependent variables (see Table 1 for means and standard deviations). This pattern of findings is not totally unexpected if it is assumed that in the present case the DICEOX schema was functioning primarily as a recall aid. That is, at the time of recall the knowledge schema may have facilitated performance by providing the student with additional retrieval cues on the essay test which were not available to students in the control group. This interpretation of the results is supported by Anderson and Pichert's (1978) finding that participants will recall different aspects of a narrative story depending on which of two schemata they are using at the time of recall. In other words, that information which is relevant to the categories subsumed under a particular schema is more likely to be recalled than information not important to that schema.

Although the lack of significance on the cloze, multiple choice, and short answer tests may be due to the fact that the knowledge schema is not useful when retrieval cues are present within the test questions as is the case with the three tests mentioned above, at least two other possible explanations for these findings should be considered. First, the cloze, multiple choice, and short answer measures may not be sufficiently sensitive to reflect treatment differences. This possibility can be substantially discounted, however, based on the fact that previous

experiments have found significant differences between treatment groups on these measures (Dansereau et al., 1979). A second possibility arises from the fact that the control group was given training that may have attenuated the differences between the two experimental groups. This possibility is supported by prior research which has shown that support strategies of the type communicated to the control group can increase performance on dependent measures similar to those used in the present study (Collins, 1978). Therefore, it appears that the current test of knowledge schema training is very conservative, and that it is not surprising that some of the dependent measures failed to show significant differences between the two groups. Under these conditions, the significant differences on the essay exam provide strong support for the efficacy of knowledge schema training.

In regard to the second experimental question, performance on the GEFT appears not to be related to knowledge schema training in that no significant interactions occurred in any of the analyses. However, the high scorers on the GEFT (field independent) significantly outperformed low scorers (field dependent) on all of the dependent measures ($p < .02$ for all analyses).

The present finding replicates an earlier unpublished study (Collins, 1979) in which high scorers on the GEFT performed significantly better than low scorers under task conditions similar to those used in the present study. In addition, studies by Pierce (1980) and Readence, Baldwin, Bean, and Dishner (1980) have shown that students who are described as field independent tend to outperform students

described as field dependent on recall and recognition tests. These results extend previous research on the relationship between field-dependence and academic achievement which has typically shown a low correlation between GEFT scores and GPA (Witkin, Moore, Oltman, Goodenough, Friedman, Owen, & Raskin, 1977). A possible reason for the present finding is that the dependent measures used in this study represent a more detailed aspect of academic performance than do broader measures such as GPA. Further, the fact that high GEFT scorers outperformed low GEFT scorers on both the cued and uncued dependent measures indicates that the locus of this individual difference may be during the input stage of processing rather than during output stages. This suggests that training during the input stage of learning may be of benefit to field dependent learners..

In summary, the results of the present experiment indicate that knowledge schema training led to significantly improved performance on an essay exam measuring comprehension and retention of prose material. This finding extends current schema theory by expanding the domain of its usage to include non-narrative prose, and by showing that training on the use of knowledge schema can facilitate the learning of ecologically valid scientific text. Furthermore, the pattern of current findings suggest that participants may be using the knowledge schema primarily as a retrieval aid. If the benefits of knowledge schema training prove to be mainly during retrieval, then the emphasis of this training should be on this stage of processing.

Finally, the results showed that high scorers (field independent) on the GEFT significantly outperformed low scorers on all the dependent measures. This finding extends past research on the GEFT

in that no previously published studies have reported a strong relationship between field dependence and tests measuring the comprehension and recall of descriptive prose.

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evolution: A longitudinal study. Journal of Educational Psychology, 1977, 69, 197-211.

Table 1

Unadjusted and Adjusted Means and Standard Deviations

for Each of the Dependent Measures

GROUP		DEPENDENT MEASURES							
		Essay Exam		Short Answer Exam		Multiple Choice Exam		Cloze Exam	
		Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
DICEOX									
High GEFT (n=7)	$\bar{x}$	20.29	18.81	29.86	27.71	23.14	22.22	15.00	13.41
	sd	4.10	5.08	6.64	2.99	2.80	3.39	3.21	2.31
Low GEFT (n=7)	$\bar{x}$	11.14	11.43	19.43	19.85	16.57	16.75	7.71	8.03
	sd	7.41	6.86	8.12	8.22	4.66	4.34	3.24	3.12
CONTROL									
High GEFT (n=7)	$\bar{x}$	13.00	11.39	28.57	25.39	21.71	21.94	12.00	12.08
	sd	6.09	6.78	6.99	8.62	2.91	3.44	3.21	2.55
Low GEFT (n=7)	$\bar{x}$	6.43	7.94	17.43	19.62	18.57	19.52	9.14	10.77
	sd	4.66	3.80	9.45	8.30	3.81	2.69	4.82	2.88